b
UNIVERSITÄT
BERN

Faculty of Business, Economics
and Social Sciences

Department of Economics

Strategic Communication with Reporting Costs

Claude Fluet und Winand Emons

16-01

Januar 2016

DISCUSSION PAPERS

Schanzeneckstrasse 1
Postfach 8573
CH-3001 Bern, Switzerland
http://www.vwi.unibe.ch

Strategic Communication with Reporting Costs*

Winand Emons[†]
Universität Bern
CEPR, CIRPEE

Claude Fluet[‡]
Université Laval
CIRPEE, CRED

January 2016

Abstract

A decision-maker relies on information of parties affected by her decision. These parties try to influence her decision by selective disclosure of facts. As is well known from the literature, competition between the informed parties constrains their ability to manipulate information. We depart from this literature by introducing a cost to communicate. Our parties trade off their reporting cost against the effect on the decision. Typically, they never reveal all information. A better outcome may be implemented if the decision-maker adopts an active stance by barring one party from reporting or through cheap talk allowing coordination on a particular equilibrium.

Keywords: disclosure, persuasion, active judging, adversarial, inquisitorial
JEL: D82, K41

*We thank Andrew Daughety and Marc Möller for helpful comments. The usual disclaimer applies.

[†]Departement Volkswirtschaftslehre, Universität Bern, Schanzeneckstrasse 1, 3001 Bern, Switzerland, Phone: +41-31-6313922, Email: winand.emons@vwi.unibe.ch.

[‡]Université Laval, Pavillon Palasis-Prince, Québec, G1V 0A6, Canada, Phone: +1-418-6562131, Email: Claude.Fluet@FSA.ulaval.ca.

1 Introduction

Decision-makers must frequently rely on the information of parties who are affected by their decisions. Being interested, these parties will try to manipulate the decision-maker's choice by, say, concealing facts or providing selective information. One possibility to counteract such manipulations is to solicit advice from parties with conflicting interests. Since any piece of information favors one party or the other, competition between the parties constrains their ability to selectively disclose facts; this allows more appropriate decisions to be made.[1] This literature typically assumes that the interested parties incur no costs for making their reports.

By contrast, we look at the case where the interested parties bear a cost to communicate their information: conveying the facts intelligibly takes time and effort. Specifically, we consider the interaction between competitive advocacy and reporting costs in a simple persuasion game. Two informed parties (experts, litigants, managers) with opposed interests can influence a decision-maker (adjudicator, judge, CEO). The principal must take a decision in a bounded continuous action space. Her payoff from the decision depends on the underlying state which is unknown to her: she wants to match the true state as closely as possible. The parties are informed about the state. They have conflicting preferences over the principal's decision. They can submit verifiable information disclosing the true state, thereby carrying the decision. Nevertheless, they incur a reporting cost when they do so.[2] The informed parties, therefore, trade off their cost of reporting against the effect on the principal's decision. As a result, the principal will sometimes receive

[1]See Milgrom and Roberts (1986), Shin (1998), Gul and Pesendorfer (2012), Bhattacharya and Mukherjee (2013), and Gentzkov and Kamenica (2015).

[2]Examples abound: The adjudicator may require a report in written form; in a trial a party may have to testify in person in the courtroom. In both these cases there is an implicit opportunity cost of preparing and disseminating the information. The cost may also be an explicit one. In a products liability case/malpractice suit/financial dispute, the true state may have to be certified by a neutral lab/an independent physician/an external auditor.

no information.

Within this framework we study three different institutions. First, we analyze unconstrained competition between the interested parties. The parties simultaneously decide whether they disclose the true state or not. The adjudicator is completely passive; once the parties have played, she updates her beliefs and makes a decision. This benchmark set-up is motivated by the *adversarial procedure* in civil litigation of common law countries.[3] Moreover, it is the framework usually discussed in the persuasion game literature on advocacy.

In the next two institutions we endow the arbiter with more possibilities to interfere. Inspired by the *inquisitorial procedure* of civil law countries, in our second scenario the arbiter can bar one of the parties from the influence game, say, by announcing beforehand that she will not hear the party or read his report.[4] In our set-up the principal cannot commit to a decision that is not ex post optimal given her beliefs and the parties' strategies at equilibrium. Barring one sender creates, however, a crude form of commitment. It puts the onus or burden of proof on the other party to provide information. If this party opts to be silent, the sequentially rational decision will tend to favor the barred sender.

The third institution for the principal to guide the persuasion game arises when there are multiple equilibria, a distinct possibility with reporting costs. At the start of the game, the principal may suggest how she will adjudicate

[3]Under the adversary system "it is for the parties to determine not only the issues which the court is to decide, but also the material on which the decision will be based. The evidence presented to the court will be that which the parties choose to present and none other. The judge may not require that a particular witness be summoned to give evidence or that a particular document be produced; he may not even question the witnesses himself except for the purpose of clarifying some doubt as to the meaning of what a witness has said under examination by counsel," Jolowicz (2000, p. 28).

[4]Under the inquisitorial system "it is for the judge to examine the witnesses, if any, it is for the judge to decide whether to summon the parties for interrogation and it is the judge who acts to obtain the assistance of an expert when required," Jolowicz (2000, p. 220). We thus analyze only one of the multiple instruments an inquisitorial judge has at hand.

if no party reports. Although these announcements are cheap talk, credible statements can be believed and allow coordination on the outcome preferred by the principal. Announcements may, therefore, be useful for shifting the onus towards one of the parties.

Next we identify circumstances when "active adjudication" may be beneficial in comparison to "passive adjudication" where the principal merely updates her beliefs and makes a decision once the parties have played. Active adjudication obviously has no useful role if the informed parties have zero reporting costs. Indeed, without reporting costs competition between opposed parties is not needed: the decision-maker's skeptical posture induces full revelation even from a single sender (Milgrom and Roberts (1986)). Nor is active adjudication useful in the canonical persuasion game à la Shin (1998): A decision-maker takes a binary decision. Two diametrically opposed senders can communicate at no cost. Yet, with some probability they have nothing to communicate which prevents complete unraveling of information. Bhattacharya and Mukherjee (2013) extend Shin's framework by endowing the decision-maker with a continuous action space, resulting in a unique equilibrium. The decision-maker gains nothing from being able to commit to a default action in the case of no report. Furthermore, it is never advantageous to bar one of the informed parties.

We show that these results need not hold with positive reporting costs.[5] When communicating is costly, there are typically states of nature that are not disclosed by the parties. Under passive adjudication, these undisclosed states may be ex ante very likely. For example, when the arbiter has symmetrical and strictly unimodal priors over the state space and the informed parties have identical reporting costs, there is a unique equilibrium with undisclosed states concentrated in the middle of the probability distribu-

[5]Our analysis nests the persuasion game of Shin (1998) and Bhattacharya and Mukherjee (2013). Reporting costs are either zero or so high that it is never worthwhile to report. Furthermore, reporting costs are the parties' private information. This constellation is strategically equivalent to the parties being informed or uninformed.

tion. By barring one party and thus shifting the burden of proof on the other party, the adjudicator moves the no-disclosure set to states which are ex ante unlikely and, therefore, matter less for appropriate decision-making. Alternatively, discarding one party may increase the probability that the other party reports by an extent that more than offsets the loss from the barred report. In general, in our set-up the adjudicator would do better if she were able to commit ex ante to a decision given no report that is not sequentially rational. Barring one sender or announcing a credible default action through cheap talk allow for crude forms of commitment that may help the adjudicator reach a better outcome.

It is well known from one-sender persuasion games that Milgrom's (1981) unraveling result depends on the assumption of costless disclosure.[6] Otherwise, the extant literature on reporting costs as such is scant.[7] This contrasts with the issue of costly acquisition of information on the part of the senders[8] or with the literature on communication through costly signaling. Kartik (2009) examines a one-sender communication problem, modeled as a signaling game, where the sender can distort the facts by incurring a "lying cost"; because the signal space is bounded, the sender does not reveal all information at equilibrium. Emons and Fluet (2009) discuss a situation with two opposed senders who can also falsify the evidence, showing that competition reduces incentives to fabricate evidence as compared to a one-sender set-up.

In a closely related paper, Demougin and Fluet (2008) consider a multistage litigation game where the judge ultimately takes a binary decision as in Shin (1998), i.e., the judge must rule in favor of the plaintiff or the defendant. They show that with small reporting costs the game generically has multiple equilibria. During the procedure an active judge ensures coordination on his

[6]See Jovanovic (1982), Verrechia (1983), or Cheong and Kim (2004).

[7]Hay and Spier (1997) analyze the allocation of the burden of proof between plaintiff and defendant from the point of view of minimizing litigation costs. Because each party's submission cost is less than the stake, the trial outcome is always without error. However, litigation expenditures will differ depending on the burden of proof assignment.

[8]See, e.g., Dewatripont and Tirole (1999), Gerardi and Yariv (2008), and Kim (2014).

preferred equilibrium through cheap talk announcements which amount to purposely shifting the burden of proof depending on the evidence submitted so far. In the present paper, by contrast, multiple equilibria are not generic because the principal's action space is continuous. However, continuity of the action space now raises the possibility that it may be better to bar a party altogether.

We proceed as follows. Section 2 presents our basic set-up which, abstracting from reporting costs, borrows much from Bhattacharya and Mukherjee (2013, 2014). Section 3 characterizes the equilibria under passive and active adjudication. Section 4 discusses circumstances where active strategies may be beneficial for the adjudicator. All proofs are relegated to the Appendix.

2 Model

There are two informed parties, A and B, and an uninformed decision-maker J who will be referred to as the adjudicator. The true state of the world is $x \in [0, 1]$ and is distributed according to the cdf $F(x)$ with full support on $[0, 1]$; $f(x)$ denotes the probability density function. The adjudicator's priors, as defined by F, are her beliefs given the information available before the informed parties take their actions.

The adjudicator must take an action y which yields her a payoff $u_J(y, x)$ that depends on the underlying state. For simplicity, $y \in [0, 1]$. The payoff is expressed in terms of a symmetric loss function, $u_J(y, x) = -v(|y - x|)$ where $v(0) = v'(0) = 0$, $v' > 0$ and $v'' > 0$. The payoff is thus maximal when the decision matches the true state.

The parties A and B are concerned about the adjudicator's decision. Party i's utility from the adjudicator's decision is $u_i(y)$ with $u_A(y) = -y$ and $u_B(y) = y$. Party A wants the decision to be as small as possible, equivalently as much to the left as possible; party B wants the decision to be as large or as much to the right as possible. Knowing the true state, they may report x to the adjudicator: either they provide hard information about the state or they communicate nothing.

Total payoff to an informed party is

$$U_i(y, m_i, c_i) = u_i(y) - C(m_i, c_i), \quad i = A, B,$$

where

$$C(m_i, c_i) = \begin{cases} 0, \text{ if } m_i = \emptyset, \\ c_i, \text{ if } m_i = x, \end{cases}$$

is the cost to the party of sending the message $m_i \in \{x, \emptyset\}$; $m_i = x$ means disclosure of the true state and $m_i = \emptyset$ denotes silence. The cost of disclosure depends on the party's reporting cost c_i.[9] Reporting costs are distributed according to the joint distribution function $G(c_A, c_B)$ with support belonging to $\mathcal{C} = [\underline{c}, \overline{c}] \times [\underline{c}, \overline{c}]$ where $\overline{c} > \underline{c} \geq 0$. The marginal distributions are denoted by $G_A(c_A)$ and $G_B(c_B)$ and satisfy $G_A(0) < 1$, $G_B(0) < 1$, meaning that a party's reporting cost is not always nil. $G(c_A, c_B)$ is common knowledge; when the distributions are degenerate, the parties' reporting costs are common knowledge.

3 Equilibrium Characterization

Let us now derive equilibria under passive and active adjudication. Our adjudicator has no commitment power; her decision is always sequentially rational given her beliefs. We first consider the benchmark where the adjudicator is completely passive. The parties simultaneously decide whether or not to disclose the true state; once the parties have played, the adjudicator updates her beliefs and makes a decision. This benchmark is motivated by the adversarial procedure. Then we turn to active adjudication. We first introduce a crude form of commitment on the part of the adjudicator: she can

[9] Reporting costs are thus constant, i.e., independent of the state. See, e.g., Verrecchia (1982) for a discussion of reporting costs that increase the more the true state departs from the mean.

bar a party from reporting so that she deals only with one sender. A judge has this possibility under the inquisitorial procedure. Finally, we exploit the fact that the reporting games may have multiple equilibria; if this is the case, the adjudicator can try to implement a particular equilibrium through cheap talk.

3.1 Two-sender equilibrium with passive adjudicator

We describe the equilibria when reporting costs are private information; the equilibria have a similar structure when costs are common knowledge. The equilibrium concept is Perfect Bayesian (PBE). A strategy for the adjudicator is a function $y(m_A, m_B)$. Party i's strategy is a function $m_i(x, c_i),\ i = A, B$.

The adjudicator's best response is to choose $y = x$ if one or both parties disclose the state. If the state is not disclosed, her best response is

$$y^* = \arg\max_y \mathbb{E}\left(u_J(y, x) \mid m_A = m_B = \emptyset\right). \tag{1}$$

The right-hand side is the adjudicator's expected payoff from decision y given her beliefs about x conditional on the event that both parties remain silent.

Party A wishes y to be as small as possible. When his reporting cost is c_A, it is therefore a dominant strategy for party A to remain silent when the true state and his reporting cost satisfy $x + c_A \geq y^*$. To see this, observe that if the state is revealed by the other party, disclosure by A does not change the decision but imposes a reporting cost; conversely, if the state is not disclosed by the other party, A is better off with the adjudicator's default action y^* than by reporting at cost c_A and inducing the decision $y = x$. Similarly, and recalling that B wishes y to be as large as possible, it is a dominant strategy for party B to remain silent when the true state and his reporting cost satisfy $x - c_B \leq y^*$.

Conversely, it is a dominant strategy for party A to report if $x + c_A < y^*$ because A knows that, given the state x, the other party will not report. Similarly, it is a dominant strategy for B to report if $x - c_B > y^*$. Given the adjudicator's default action when she gets no reports, the no-disclosure event is therefore

$$N(y^*) = \{(x, c_A, c_B) : y^* - c_A \leq x \leq y^* + c_B,\ x \in X,\ (c_A, c_B) \in \mathcal{C}\}. \qquad (2)$$

Condition (1) can be rewritten as

$$y^* = \arg\max_y \mathbb{E}\left(u_J(y, x) \mid N(y^*)\right). \qquad (3)$$

An equilibrium is completely characterized by a solution y^* to (3).

Proposition 1: *A PBE for the two-sender game with passive adjudicator always exists. In any equilibrium $y^* \in (0, 1)$. The informed parties' strategies are*

$$m_A(x, c_A) = \begin{cases} x, & \text{if } x + c_A < y^*, \\ \emptyset, & \text{otherwise,} \end{cases} \qquad (4)$$

$$m_B(x, c_B) = \begin{cases} x, & \text{if } x - c_B > y^*, \\ \emptyset, & \text{otherwise.} \end{cases} \qquad (5)$$

The adjudicator's strategy is

$$y(m_A, m_B) = \begin{cases} x, & \text{if } m_A = x \text{ or } m_B = x, \\ y^*, & \text{otherwise,} \end{cases} \qquad (6)$$

where

$$y^* = \arg\max_y \int_{\mathcal{C}} \int_{\max(0, y^* - c_A)}^{\min(y^* + c_B, 1)} u_J(y, x) f(x)\, dx\, dG(c_A, c_B). \qquad (7)$$

Note that the right-hand side of (7) is not a conditional expectation. However, condition (7) is equivalent to

$$\begin{aligned} y^* &= \arg\max_y \int_{\mathcal{C}} \int_{\max(0, y^* - c_A)}^{\min(y^* + c_B, 1)} u_J(y, x) f(x)\, dx\, dG(c_A, c_B) / \Pr(N(y^*)) \\ &= \arg\max_y \mathbb{E}\left(u_J(y, x) \mid N(y^*)\right). \end{aligned}$$

Two additional observations are in order. First, as emphasized in the Introduction, there may be multiple equilibria; we provide examples in Section 4. Second, it is useful to make a distinction between an interior and a corner equilibrium. An equilibrium is *interior* if both parties disclose with positive probability. In a *corner* equilibrium only one party discloses with positive probability, the other party is always silent. An outcome is referred to as a corner-i equilibrium if only party i is active. Obviously, it could be that reporting costs are always so high that both parties always remain silent. To rule out this possibility, we assume $\underline{c}_A + \underline{c}_B < 1$ where $\underline{c}_A$ and $\underline{c}_B$ are the lower bounds of G's support.

Corollary 1: *In the two-sender game with passive adjudicator, at least one party discloses with positive probability.*

In an equilibrium with y^* as the adjudicator's default action, both parties remain silent for states in

$$S := [y^* - \underline{c}_A, y^* + \underline{c}_B] \cap [0, 1].$$

We refer to S as the no-disclosure set. In an interior equilibrium, S is in the interior of the state space as illustrated in Figure 1a. When party A's reporting cost equals the minimum $\underline{c}_A$, he discloses if $x < y^* - \underline{c}_A$. When his cost c_A is greater than $\underline{c}_A$, he discloses only for smaller values of the true state, i.e., when $x < y^* - c_A$.

Figure 1b illustrates a corner-A equilibrium. The no-disclosure set is of the form $[y^* - \underline{c}_A, 1]$. Party B is always silent because $x - \underline{c}_B < y^*$ for all x in the state space, which implies $x - c_B < y^*$ for all c_B in the support. Condition (7) then reduces to

$$y^* = \arg\max_y \int_{\underline{c}}^{\overline{c}} \int_{\max(0, y^* - c_A)}^{1} u_J(y, x) f(x)\, dx\, dG_A(c_A).$$

If in addition A's cost is always $\underline{c}_A$, i.e., the distribution is degenerate, the condition further reduces to

$$y^* = \arg\max_y \int_{y^*-\underline{c}_A}^{1} u_J(y,x) f(x)\, dx. \tag{8}$$

Condition (8) is equivalent to

$$\begin{aligned} y^* &= \arg\max_y \int_{y^*-\underline{c}_A}^{1} u_J(y,x) \left(\frac{f(x)}{1-F(y^*-\underline{c}_A)} \right) f(x)\, dx \\ &= \arg\max_y \mathbb{E}\left(u_J(y,x)\right) \mid x > y^* - \underline{c}_A\right). \end{aligned}$$

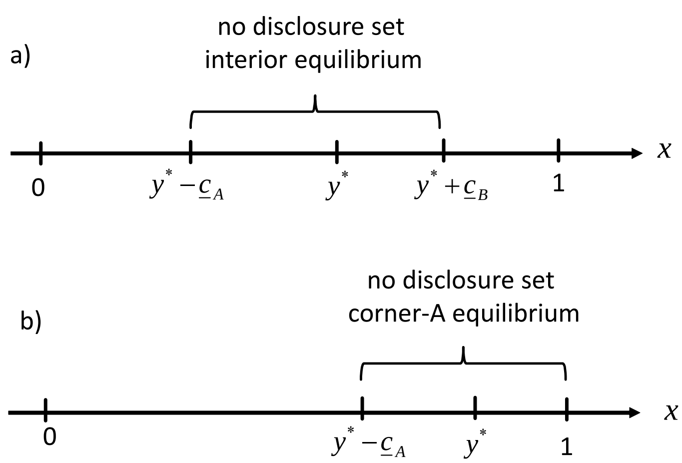

Fig. 1. Interior and corner equilibria

3.2 One-sender equilibrium

In the rest of this section we discuss two ways how the adjudicator may play an active role in the communication game. First, as we show in the next section, competition between the informed parties to influence the adjudicator may not be desirable from her point of view. The adjudicator may prefer not to be influenced by a party by refusing to listen to him. We modify the game by adding an initial stage where the adjudicator announces whether she listens to both parties or whether one party is barred from reporting (this would specify which one). In the latter case, the continuation game that ensues is referred to as a one-sender game.

Proposition 2: *A PBE for the one-sender game always exists. If only A is allowed to report, A's strategy is given by (4) and the adjudicator's strategy is*

$$y(m_A) = \begin{cases} x, & \textit{if } m_A = x, \\ y^*, & \textit{otherwise}, \end{cases} \tag{9}$$

where

$$y^* = \arg\max_y \int_{\underline{c}}^{\overline{c}} \int_{\max(0, y^* - c_A)}^{1} u_J(y, x) f(x)\, dx\, dG_A(c_A). \tag{10}$$

If only B is allowed to report, B's strategy is given by (5) and the adjudicator's strategy is

$$y(m_B) = \begin{cases} x, & \textit{if } m_B = x, \\ y^*, & \textit{otherwise}, \end{cases} \tag{11}$$

where

$$y^* = \arg\max_y \int_{\underline{c}}^{\overline{c}} \int_{0}^{\min(y^* + c_B, 1)} u_J(y, x) f(x)\, dx\ dG_B(c_B). \tag{12}$$

In either case $y^* \in (0, 1)$.

Allowing only one party to report forces a corner equilibrium. When only A is allowed, large values of x will never be reported but smaller values (those satisfying $x < y^* - \underline{c}_A$) will be disclosed, at least with some probability. Conversely, if B is the only one to report, small values of x will never be disclosed.

Corollary 2: *If the two-sender game has a corner-i equilibrium, then this is an equilibrium of the one-sender game where only i is allowed to report. The converse is not true.*

There is a distinction between one-sender and two-sender corner equilibria. The outcome, by force a corner equilibrium, of the one-sender game where only i can report need not be an equilibrium of the two-sender game.

The reason is that competition between the informed parties may induce an interior equilibrium or the opposite corner equilibrium. It is obviously not in the adjudicator's interest to prohibit both parties from reporting. The next result parallels Corollary 1.

Corollary 3: *There is at least one one-sender equilibrium where the allowed party reports with positive probability.*

3.3 Equilibria with announcements

Alternatively, the adjudicator can play an active role by trying to influence the parties at the beginning of the game. Specifically, the adjudicator announces the decision she intends to make if she gets no report. Because the adjudicator cannot commit to a particular course of action, such announcements are cheap talk. They have no effect if they are not believed. Nevertheless, it is reasonable to assume that the parties believe credible statements about planned behavior, the standard requirements for credibility being that announcements are self-committing and self-signaling; see Farrell and Rabin (1996). An announcement is self-committing if the adjudicator's best move is to follow suit if she thinks the announcement is believed. An announcement is self-signaling if the adjudicator has no incentives to mislead; see Aumann, (1990) and Baliga and Morris (2002).

Consider a particular equilibrium y^* of either the two-sender or one-sender games discussed so far. Let Y denote the set of possible equilibria. In the modified game with announcements, we add a stage where the adjudicator announces a default decision $\bar{y}$ should there be no report. The announcement is *self-committing* if $\bar{y} \in Y$; that is, if the adjudicator thinks the announcement is believed and the parties play accordingly, it is sequentially rational for her to abide by $\bar{y}$. In addition, the announcement is *self-signaling* if the adjudicator does not want the parties to believe she will play $\bar{y}$ if she intends to play otherwise. Let $\overline{U}_J(y^*)$ denote the adjudicator's ex ante expected payoff under the continuation equilibrium y^*. Formally, $\overline{U}_J(y^*)$ is the right-hand side of (7), (10), or (12) evaluated at the equilibrium default decision y^*.

Proposition 3: $\bar{y} = \arg\max_{y^* \in Y} \overline{U}_J(y^*)$ *is an equilibrium announcement and outcome satisfying the condition that credible announcements by the adjudicator are believed.*

Announcements allow the adjudicator to induce coordination on the equilibrium she prefers. Obviously, announcements have no effect if the equilibrium set of the continuation game is a singleton.

4 Active versus Passive Adjudication

Let us now discuss circumstances where the active instruments yield higher payoff for the arbiter than passive adjudication. Before we start this discussion note that if the best outcome among all potential outcomes is an interior equilibrium, this can only be ensured through announcements, unless it arises spontaneously as the unique equilibrium of the two-sender game. If the best outcome is a corner equilibrium that is also an equilibrium of the two-sender game, then it can be achieved through announcements in the two-sender set-up or by allowing only the appropriate party to report. By contrast, if the best outcome is the equilibrium of a one-sender game that is not an equilibrium in the two-sender set-up, then this outcome can only be implemented by discarding one party.

4.1 Uninformed priors with known reporting costs

We start with a benchmark case where active adjudication provides no benefit. In this benchmark, the adjudicator has completely "uninformed" priors about the true state, meaning F is uniform.[10] The adjudicator has, however, perfect knowledge of the informed parties' reporting costs.

Proposition 4: *When F is uniform and reporting costs are common knowledge, the two-sender game (i) has a continuum of payoff equivalent equilibria if $c_A = c_B =: c$ and (ii) a unique corner-i equilibrium if $c_i < c_{-i}$, $i, -i = A, B$. In either case active adjudication yields no benefit.*

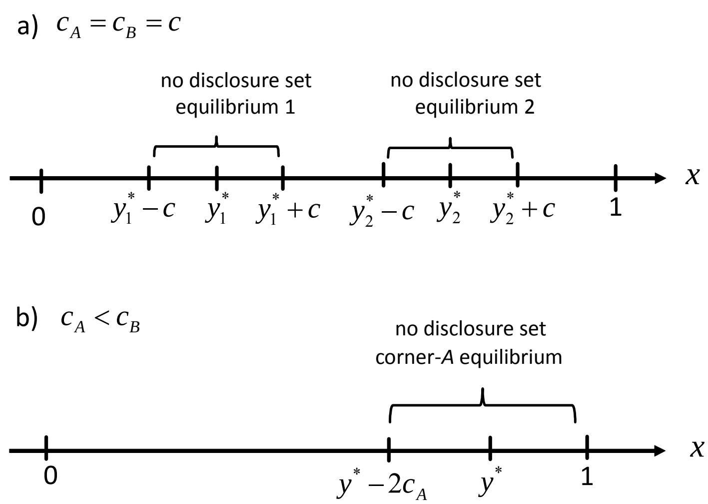

Fig. 2. Equilibria with uniform priors

In Figure 2a we illustrate two equilibria for the case where both parties have the same reporting cost c. Because the loss function $v(|y - x|)$ is symmetric and all states are equally likely, any $y^* \in [c, 1 - c]$ is an equilibrium. These equilibria yield the adjudicator the same payoff because, given her uniform priors, she is indifferent as to the location of the no-disclosure interval. Figure 2b illustrates the corner-A equilibrium when $c_A < c_B$. $y^* = 1 - c_A$ and the no-disclosure interval is $[1 - 2c_A, 1]$. Barring A instead would force

[10]This is just Laplace's principle of insufficient reason, according to which if there is no reason to discriminate between several events, the best strategy is to consider them as equally likely.

the corner-B equilibrium $y^* = c_B$. This is detrimental because the no-disclosure interval $[0, 2c_B]$ when only B reports is larger than in the corner-A equilibrium.

When either of the conditions in Proposition 4 does not hold, there will be situations where active adjudication may play a useful role.

4.2 Uninformed priors with unknown reporting costs

Let us now relax the condition that reporting costs are common knowledge. Actively barring one party may now be beneficial even if this party has lower expected reporting costs than the party allowed to report.

Consider the following example. A's reporting cost is common knowledge and equals c_A. B's cost is $c_B = 0$ with probability $G_B(0) =: p$; otherwise it is $c_B = 1$. With the high cost realization B thus does not report irrespective of the state. The loss function is the square error $v(|y - x|) = (y - x)^2$. The first-order condition for (7) in the two-sender game is then

$$p \int_{(y^*-c_A)^+}^{y^*} -2(y^* - x) f(x)\, dx + (1 - p) \int_{(y^*-c_A)^+}^{1} -2(y^* - x) f(x)\, dx = 0.$$

where $(y^* - c_A)^+$ is shorthand for $\max(0, y^* - c_A)$. The condition yields

$$y^* = \frac{p \int_{(y^*-c_A)^+}^{y^*} x f(x)\, dx + (1 - p) \int_{(y^*-c_A)^+}^{1} x f(x)\, dx}{p \int_{(y^*-c_A)^+}^{y^*} f(x)\, dx + (1 - p) \int_{(y^*-c_A)^+}^{1} f(x)\, dx}$$

where the right-hand side is the expected value conditional on no-disclosure. Substituting for the uniform distribution gives us

$$y^* = \begin{cases} 1 - c_A/\sqrt{1 - p}, & \text{if } p < p_0, \\ (\sqrt{1 - p} - 1 + p)/p, & \text{if } p \geq p_0, \end{cases}$$

where

$$p_0 = (1 - 2c_A)/(1 - c_A)^2.$$

When $p < p_0$, $y^* > c_A$ and we have an interior equilibrium where both parties report with some probability. When $p \geq p_0$, $y^* \leq c_A$ and the outcome is a corner-B equilibrium where only B reports.

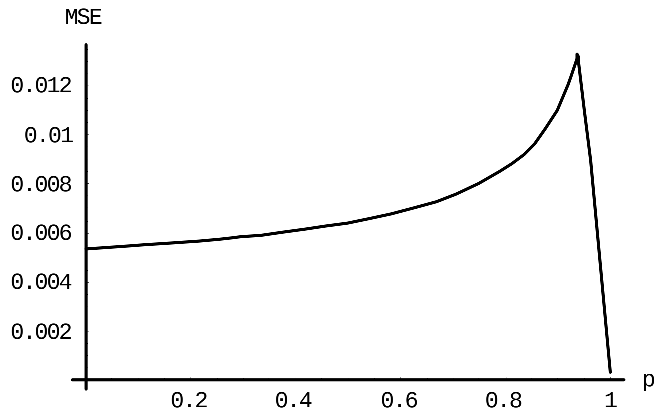

Fig. 3. Mean-square error in the two-sender game with uniform priors, $c_A = .2$, $c_B = 0$ with probability p and is otherwise arbitrarily large

Figure 3 depicts the adjudicator's expected loss (the mean square error) as a function of p for $c_A = .2$. When $p = 0$, B never discloses and the loss is the same as in the one-sender game where only A is allowed to report. A larger p decreases the default decision y^*: the more likely it is that B has zero costs, the more "no report" suggests a small value of x. A lower y^*, however, reduces the probability that A reports. It turns out that the loss from this reduction more than offsets the gain from B's higher reporting probability. The adjudicator's expected loss, therefore, increases in p for $p \leq p_0 = .937$ where the equilibrium switches from interior to corner-B. In the corner-B regime the expected loss is obviously decreasing in p. As p approaches unity, y^* tends to zero and B always discloses so that there is complete unraveling. Straightforward computations yield that for $p < .987$ the arbiter does better by actively barring B, thus forcing a corner-A equilibrium rather than adjudicating passively and implementing an interior or a corner-B equilibrium. Interestingly, this is not only the case when A's reporting cost is lower than B's expected cost but also when it is higher.

4.3 Informed Priors

Consider now the case where the adjudicator has specific views concerning the likely values of the state. Intuitively, strong priors suggest that active adjudication may be beneficial. Suppose, for example, F is skewed with most of the probability mass concentrated on small values of x. The two-sender game may nevertheless have an interior equilibrium. If A's reporting cost is not too large, it may be beneficial to force a corner-A equilibrium by barring B. Alternatively, suppose F is strictly unimodal. If the distribution is symmetric and the parties have the same reporting cost c, the two-sender game has a unique interior equilibrium with $y^* = 1/2$. The no-disclosure interval $[1/2 - c, 1/2 + c]$ is centered. Depending on the size of the reporting cost and the precision of prior beliefs, the interval may include most of the probability mass. It may be beneficial to force a corner equilibrium by barring one party: no disclosure will then occur for values of the state that are a priori unlikely. We now provide examples for both arguments.

The adjudicator's priors are given by the Beta distribution $\mathcal{B}(a, b)$ with parameters $a > 0$ and $b > 0$. The mean is given by $\mu = a/(a + b)$ and the mode by $m = (a - 1)/(a + b - 2)$ if $a > 1$ and $b > 1$; for $a < 1$ and $b \geq 1$, the density is everywhere decreasing so that $m = 0$. In all our examples, the distribution is unimodal; it is either symmetric or skewed with mean and mode less than or equal to $1/2$. See Figure 4. The loss function is the square error.

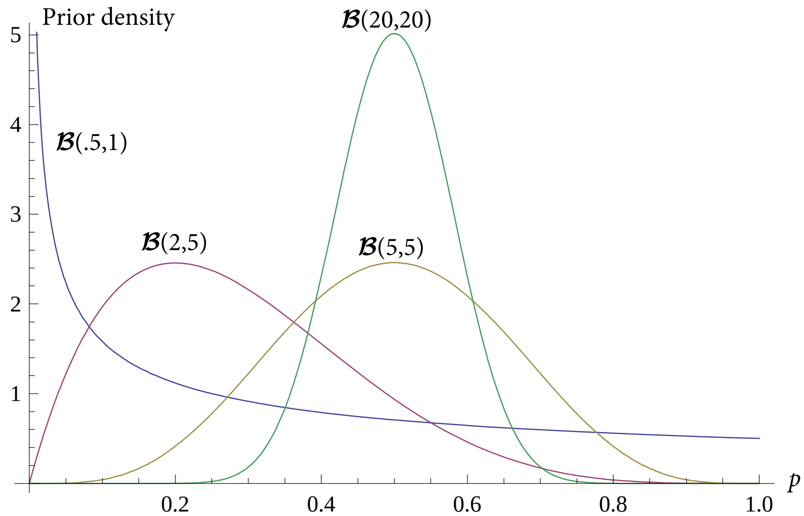

Fig. 4. Some of the Beta distributions used in Table 1

In Table 1 the reporting costs are common knowledge. $c_A = .1$ and $c_B \in \{.1, .15, .2\}$. The first case in Table 1 is $\mathcal{B}(.5, 1)$ with $\mu = 1/3$ and mode $m = 0$.[11] When $c_A = c_B = .1$, the two-sender game has a unique corner-B equilibrium with $y^* = .05$. The adjudicator does, however, better by barring B, thus forcing a corner-A equilibrium.[12] When B's cost is $c_B = .15$, the two-sender game has three equilibria: a corner-A, a corner-B, and an interior equilibrium. The best outcome from the adjudicator's point of view is the corner-A equilibrium. This outcome can be ensured through an announcement strategy within the two-sender game; alternatively it can be implemented by discarding B. When B's cost is $c_B = .20$, the two-sender game has a unique corner-A equilibrium. There is no need for the principal to actively adjudicate.

Table 1 about here

[11] In Table 1 the type of equilibrium is denoted *ca* for corner-A, and *cb* for corner-B, and *in* for interior.

[12] Due to the skewness of the distribution, the no-disclosure set of the corner-A equilibrium is about twice the size of the no-disclosure set of the corner-B equilibrium. Yet, the no-disclosure states in the corner-A equilibrium are ex ante very unlikely as compared to the corner-B equilibrium.

For $\mathcal{B}(.5, 2)$, $\mathcal{B}(1, 5)$, and $\mathcal{B}(2, 5)$ a corner-A equilibrium is always the best option for the adjudicator. The two-sender game never has a corner-A equilibrium. Therefore, the adjudicator always has to bar B to enforce the corner-A equilibrium.

Next consider the last two cases in Table 1 with symmetric distributions. In all cases the two-sender game has a unique interior equilibrium which, with one exception, is also best for the adjudicator. Only for the concentrated distribution $\mathcal{B}(10, 10)$ and $c_B = .2$ a corner-A equilibrium is better.

Qualitatively similar results hold when reporting costs are private information. In Table 2 the parties' costs are i.i.d and uniformly distributed over $\{.05, .1, .15, .2\}$.

Table 2 about here

Finally, in Table 3 we provide examples where reporting costs are symmetric and small; the densities are concentrated and symmetric. For $c_A = c_B = .1$, the interior equilibrium with $y^* = 1/2$ yields the minimum error. Yet, for $c_A = c_B = .02$, the arbiter does better with a corner equilibrium. Even though the no-disclosure set is larger than the no-disclosure set of the interior equilibrium, silence is ex ante sufficiently unlikely in the corner equilibria as compared to the interior ones.[13]

Table 3 about here

4.4 Comparison with Full Commitment

The preceding results are driven by the fact that, except in particular cases, the adjudicator does better if she is able to commit to some default action

[13]Note that in all our numerical examples the one-sender games always have unique equilibria. However, it is straightforward to provide cases where even the one-sender set-up yields multiple equilibria as well. An announcement strategy is then useful to allow coordination on the equilibrium with the least likely no-disclosure set.

in case of no report. Announcing self-committing default decisions or refusing to hear a party are crude substitutes for the capacity to fully commit to a decision that need not be sequentially rational given the adjudicator's posterior beliefs.

If the adjudicator has full commitment capacity, she announces the default action $\hat{y}$ maximizing

$$\overline{U}_J(\hat{y}) = \int_{\mathcal{C}} \int_{\max(0,\hat{y}-c_A)}^{\min(\hat{y}+c_B,1)} u_J(\hat{y}, x) f(x)\, dx\, dG(c_A, c_B).$$

The parties' strategies are as in Proposition 1 but with $\hat{y}$ substituted for y^*. If the problem has an interior solution, it satisfies the first-order condition $\overline{U}'_J(\hat{y}) = 0$ where

$$\begin{aligned}
\overline{U}'_J(\hat{y}) \quad = \quad & \int_{\mathcal{C}} \int_{\max(0,\hat{y}-c_A)}^{\min(\hat{y}+c_B,1)} u'_J(\hat{y}, x) f(x)\, dx\, dG(c_A, c_B) \\
& + \int_{\underline{c}}^{\overline{c}} \left[u_J(\hat{y}, z)) f(z)) \frac{dz}{d\hat{y}} \right]_{z=\min(\hat{y}+c_B,1)} dG_B(c_B) \\
& - \int_{\underline{c}}^{\overline{c}} \left[u_J(\hat{y}, z)) f(z)) \frac{dz}{d\hat{y}} \right]_{z=\max(0,\hat{y}-c_A)} dG_A(c_A), \qquad (13)
\end{aligned}$$

with $u'_J(y, x) := \partial u_J(y, x)/\partial y$.

At an equilibrium without the ability to commit, i.e., $\hat{y} = y^*$, the first term in (13) is equal to zero because it is the first-order condition for condition (7). However, the sum of the last two terms will in general differ from zero, implying that the adjudicator benefits from being able to commit to an action that differs from the ex post optimal decision.

Moreover, a default action satisfying the first-order condition for a maximum under full commitment need not be a solution because the above problem is typically not concave. Consider, e.g., the case of uniform priors and known costs of Proposition 4. At an equilibrium without commitment, when both parties' reporting costs are equal to c, the last two terms in (13) computed at $\hat{y} = y^*$ reduce to

$$u_J(y^*, y^* + c) - u_J(y^*, y^* - c) = 0.$$

The equality follows from the symmetry of the loss function. However, as we show in the next result, the adjudicator's default action under full commitment is a corner solution putting the burden of proof fully on one party.

Corollary 4: *When F is uniform and reporting costs are common knowledge, an adjudicator with full commitment capacity announces $\hat{y} = 0$ or $\hat{y} = 1$ if $c_A = c_B =: c$ and $\hat{y} = 1$ if $c_A < c_B$.*

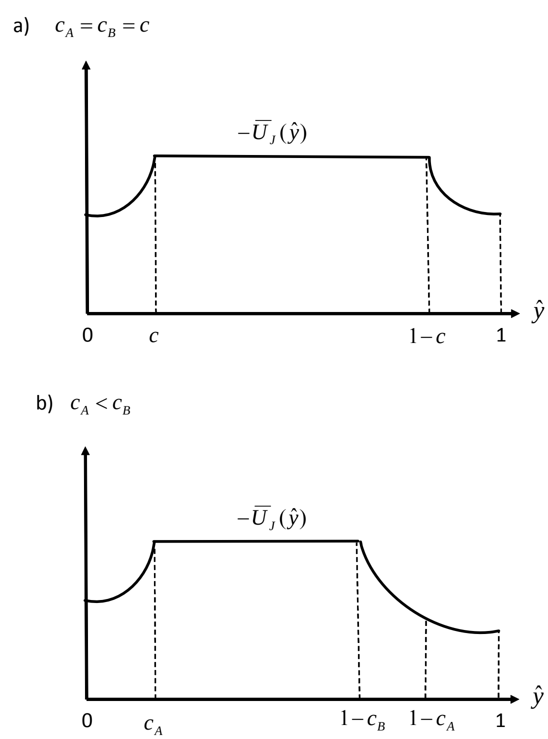

Fig. 5. Expected loss as a function of $\hat{y}$ under full commitment with uniform priors and known costs

Figure 5 illustrates the adjudicator's expected loss as a function of the default action. When both parties have the same reporting cost c, the equilibrium y^* without commitment is in the interval $[c, 1-c]$; the no-disclosure set then has length $2c$. When reporting is cheaper for A, the equilibrium is the corner-A equilibrium with $y^* = 1 - c_A$ and the no-disclosure set has length $2c_A$. In either case, the ability to commit reduces the no-disclosure set by half.

An exception where commitment provides no benefit is when each party's reporting cost is either zero with some probability or otherwise takes values greater or equal than unity. When the cost is zero, the adjudicator's payoff in the second or third term of (13) is $u_J(\hat{y}, \hat{y}) = 0$, so the term vanishes. When the cost is large, the integrand in the last two terms is evaluated at $z = 0$ or $z = 1$ so that $dz/d\hat{y} = 0$ and the terms also vanish. This case is strategically equivalent to the canonical game where each party can be either informed or uninformed, as in Bhattacharya and Mukherjee (2013).

5 Concluding Remarks

We have discussed a simple set-up showing that a sophisticated uninformed principal can often do better than merely wait passively for interested competing parties to decide whether they will provide information. This holds even though the decision-maker has limited power — she can force no one and cannot really commit to anything — and even though she may be ignorant of the interested parties' opportunity costs in reporting information.

Our results do not mean, of course, that competition between interested parties is not generally useful, as in the environments studied by Milgrom and Roberts (1986) or recently by Gentzkov and Kamenica (2015). Nevertheless, the analysis does show that reporting costs introduce a wedge between purely passive adjudication and a more active stance. A decision-maker may wish to make clear which interested party she will listen to. She may also gain by announcing how she will decide if she hears nothing.

We have focused on parties with completely opposed interests. In many situations advisers may, however, have overlapping agendas. Reporting costs then introduce the possibility that advisers free-ride on the reports of others.

An active stance on the part of the arbiter will often be beneficial, but the issue now is to prevent free-riding. For instance, in our set-up, if both parties have the same preferences and identical reporting costs, the equilibrium will involve mixed strategies: some states are never disclosed, some states are disclosed only with some probability which increases the more favorable the state is to the informed parties. Barring one party altogether is then unambiguously beneficial.

Finally, we have evaluated passive versus active adjudication solely on the basis of error costs. A natural extension of our approach is to also take reporting costs into account.[14] If, for example, the arbiter gives a lot of weight to submission and little weight to error costs, it may be optimal to bar both parties from reporting.

Appendix

Proof of Proposition 1. Let the parties's strategies be as described in (4) and (5) for some y^*. The probability of the no-disclosure event is then

$$\Pr(N(y^*)) = \int_{\mathcal{C}} \int_{\max(0,y^*-c_A)}^{\min(y^*+c_B,1)} f(x)\,dx\,dG(c_A,c_B).$$

Applying Bayes' rule, the adjudicator's expected payoff from decision y conditional on no disclosure is therefore

$$\mathbb{E}\left(u_J(y,x) \mid N(y^*)\right) = \int_{\mathcal{C}} \int_{\max(0,y^*-c_A)}^{\min(y^*+c_B,1)} u_J(y,x) f(x)\,dx\,dG(c_A,c_B)/\Pr(N(y^*)).$$

Maximizing this expression with respect to y is therefore equivalent to maximizing the numerator. The necessary and sufficient condition is

$$\int_{\mathcal{C}} \int_{\max(0,y^*-c_A)}^{\min(y^*+c_B,1)} u'_J(y,x) f(x)\,dx\,dG(c_A,c_B) = 0$$

where $u'_J(y,x) := \partial u_J(y,x)/\partial y$. Sufficiency follows from $u''_J(y,x) < 0$.

Define

$$Z(y) = \int_{\mathcal{C}} \int_{\max(0,y-c_A)}^{\min(y+c_B,1)} u'_J(y,x) f(x)\,dx\,dG(c_A,c_B)$$

[14]See, e.g., Emons and Fluet (2009) for such a set-up.

so that y is an equilibrium if $Z(y) = 0$. The function $Z(y)$ is easily seen to be continuous. Recall that $u_J'(y,x) > 0$ if $y < x$ and $u_J'(y,x) < 0$ if $y > x$. Therefore, because $\Pr(c_B > 0) > 0$,

$$Z(0) = \int_{\mathcal{C}} \int_0^{\min(y+c_B,1)} u_J'(0,x) f(x)\, dx\, dG(c_A, c_B) > 0.$$

Similarly, because $\Pr(c_A > 0) > 0$,

$$Z(1) = \int_{\mathcal{C}} \int_{\max(0,1-c_A)}^{1} u_J'(1,x) f(x)\, dx\, dG(c_A, c_B) < 0.$$

Hence, there exists $y \in (0,1)$ such that $Z(y) = 0$. QED

Proof of Corollary 1. Let y^* be the equilibrium decision under no disclosure. If $\underline{c}_A$ and $\underline{c}_B$ are the lower bounds of reporting costs, A reveals with some probability if $x \in [0, y^* - \underline{c}_A)$ and B reveals with some probability if $x \in (y^* + \underline{c}_B, 1]$. At least one of these intervals is not empty. Suppose not. Then $y^* - \underline{c}_A \leq 0$ and $y^* + \underline{c}_B \geq 1$ yielding $\underline{c}_A + \underline{c}_B \geq 1$, which contradicts $\underline{c}_A + \underline{c}_B < 1$. QED

Proof of Proposition 2. Consider the one-sender continuation game where only A is allowed to report. A's strategy is as described in (9) for some y^*. Using the same argument as in the proof of Proposition 1, the adjudicator's best response when she gets no report is y satisfying

$$\int_{\underline{c}}^{\overline{c}} \int_{\max(0,y^*-c_A)}^{1} u_J'(y,x) f(x)\, dx\, dG_A(c_A) = 0.$$

Define

$$Z(y) = \int_{\underline{c}}^{\overline{c}} \int_{\max(0,y-c_A)}^{1} u_J'(y,x) f(x)\, dx\, dG_A(c_A) \tag{14}$$

so that y is an equilibrium if $Z(y) = 0$. Then

$$Z(0) = \int_{\underline{c}}^{\overline{c}} \int_0^1 u_J'(0,x) f(x)\, dx\, dG_A(c_A) > 0$$

and

$$Z(1) = \int_{\underline{c}}^{\overline{c}} \int_{\max(0,1-c_A)}^{1} u_J'(1,x) f(x)\, dx\, dG_A(c_A) < 0$$

where the latter follows because $G_A(0) < 1$. Hence, there exists $y \in (0,1)$ solving $Z(y) = 0$. QED

Proof of Corollary 2. The first part is obvious given Proposition 2. The second part is illustrated by the examples of Section 4. QED

Proof of Corollary 3. In a one-sender game, if the allowed party never reports, $y^* = \mu$ where μ is the prior mean. When only A is allowed, he never reports if $\mu - \underline{c}_A \leq 0$. When only B is allowed, he never reports if $\mu + \underline{c}_B \geq 1$. Both inequalities together yield $\underline{c}_A + \underline{c}_B \geq 1$, which contradicts $\underline{c}_A + \underline{c}_B < 1$. QED

Proof of Proposition 3. For $\bar{y}, y^* \in Y$, let $\overline{U}(\bar{y}, y^*)$ be the adjudicator's ex ante expected payoff when she plans to play the default action $\bar{y}$ but the informed parties play a best response to y^*, that is,

$$\overline{U}(\bar{y}, y^*) = \int_{\mathcal{C}} \int_{\max(0, y^* - c_A)}^{\min(y^* + c_B, 1)} u_J(\bar{y}, x) f(x) \, dx \, dG(c_A, c_B).$$

Borrowing from Baliga and Morris (2002), the announcement $\bar{y}$ is self-signaling if $\overline{U}(\bar{y}, \bar{y}) \geq \overline{U}(\bar{y}, y^*)$, i.e., the adjudicator would like the informed parties to play a best response to $\bar{y}$. By definition of an equilibrium in the continuation game, $\overline{U}(y^*, y^*) \geq \overline{U}(\bar{y}, y^*)$. The announcement $\bar{y} \in Y$ is, therefore, self-signaling (as well as self-committing) if $\overline{U}(\bar{y}, \bar{y}) \geq \overline{U}(y^*, y^*)$ for all $y^* \in Y$. Hence, the announcement in the proposition satisfies the credibility conditions and is the one that will be made by the adjudicator. QED

Proof of Proposition 4. When reporting costs are $c_A = c_B = c$, for any $y \in [c, 1 - c]$ and given that $f(x) = 1$,

$$\int_{y-c}^{y+c} u'_J(y, x) f(x) \, dx = -\int_{y-c}^{y} v'(y - x) \, dx + \int_{y}^{y+c} v'(x - y) \, dx = 0. \tag{15}$$

Thus, any such y is an equilibrium. The adjudicator's ex ante expected payoff is

$$\overline{U}_J(y) = \int_{y-c}^{y+c} u_J(y, x) f(x) \, dx = -2 \int_{y-c}^{y} v(y - x) \, dx$$

and is constant in y,

$$\begin{aligned} \frac{d\overline{U}_J(y)}{dy} &= -2 \int_{y-c}^{y} v'(y - x) \, dx + 2 \left[v(c) - v(0) \right] \\ &= 2v(y - x)|_{y-c}^{y} + 2 \left[v(c) - v(0) \right] \\ &= 0. \end{aligned}$$

When reporting costs differ, by the same argument as in (15), an interior equilibrium requires that y^* be the mid-point of $[y - c_A, y + c_B]$, which is impossible if $c_A < c_B$. The equilibrium is then a corner-A equilibrium where y^* is the mid-point of $[y^* - c_A, 1]$, i.e., $y^* = 1 - c_A$. This is indeed a corner-A equilibrium because $y^* + c_B = 1 - c_A + c_B > 1$. A similar argument shows that a corner-B equilibrium does not exist. QED

Proof of Corollary 4. The adjudicator's expected payoff is

$$\overline{U}_J(\hat{y}) = -\int_{\max(0,\hat{y}-c_A)}^{\hat{y}} v(\hat{y} - x)\, dx - \int_{\hat{y}}^{\min(\hat{y}+c_B,1)} v(x - \hat{y})\, dx$$

When $c_A = c_B = c$ and borrowing from the proof of Proposition 4, for any $\hat{y} \in [c, 1 - c]$,

$$\overline{U}_J(\hat{y}) = -2 \int_{\hat{y}-c}^{\hat{y}} v(\hat{y} - x)\, dx$$

which is constant in $\hat{y}$. For $\hat{y} \in [0, c]$,

$$\overline{U}_J(\hat{y}) = -\int_0^{\hat{y}} v(\hat{y} - x)\, dx - \int_{\hat{y}}^{\hat{y}+c} v(x - \hat{y})\, dx$$

and

$$\overline{U}'_J(\hat{y}) = -v'(\hat{y}) < 0 \text{ for } \hat{y} \neq 0.$$

Hence $\hat{y} = 0$ maximizes the expected payoff for $\hat{y} \in [0, 1 - c]$. By symmetry, $\hat{y} = 1$ is best for $\hat{y} \in [c, 1]$. In either case

$$\overline{U}_J(0) = \overline{U}_J(1) = -\int_0^c v(x)\, dx.$$

Consider next the case $c_A < c_B$, so that $c_A < 1 - c_B$ by $\underline{c}_A + \underline{c}_B < 1$. When $\hat{y} \in [c_A, 1 - c_B]$,

$$\overline{U}_J(\hat{y}) = -\int_{\hat{y}-c_A}^{\hat{y}} v(\hat{y} - x)\, dx - \int_{\hat{y}}^{\hat{y}+c_B} v(x - \hat{y})\, dx$$

which is constant in $\hat{y}$. For $\hat{y} \in [1 - c_B, 1]$,

$$\overline{U}_J(\hat{y}) = -\int_{\hat{y}-c_A}^{\hat{y}} v(\hat{y} - x)\, dx - \int_{\hat{y}}^{1} v(x - \hat{y})\, dx$$

and

$$\overline{U}'_J(\hat{y}) = v'(1 - \hat{y}) > 0 \text{ for } \hat{y} \neq 1.$$

Hence $\hat{y} = 1$ is best for $\hat{y} \in [c_A, 1]$ with expected payoff

$$\overline{U}_J(1) = -\int_{1-c_A}^{1} v(1-x)\,dx = -\int_{0}^{c_A} v(x)\,dx$$

For $\hat{y} \in [0, c_A]$,

$$\overline{U}_J(\hat{y}) = -\int_{0}^{\hat{y}} v(\hat{y}-x)\,dx - \int_{\hat{y}}^{\hat{y}+c_B} v(x-\hat{y})\,dx$$

and

$$\overline{U}'_J(\hat{y}) = -v'(\hat{y}) < 0 \text{ for } \hat{y} \neq 0.$$

Hence $\hat{y} = 0$ is best for $\hat{y} \in [0, 1-c_B]$ with expected payoff

$$\overline{U}_J(0) = -\int_{0}^{c_B} v(x)\,dx.$$

Because $c_A < c_B$, $\overline{U}_J(1) > \overline{U}_J(0)$. QED

Table 1. Square-error loss function and Beta priors

Beta		One-sender A		One-sender B		Two-sender		
(a,b)	c_B	y^*	MSE (×100)	y^*	MSE (×100)	y^*	MSE (×100)	Type
$(.5,1)$	.10	.896	.037*	.050	.077	.050	.077	*cb*
						.075	.213	*cb*
	.15	.896	.037*	.075	.213	.116	.207	*in*
						.896	.037*	*ca*
	.20	.896	.037*	.100	.438	.896	.037*	*ca*
$(.5,2)$	.10	.790	.021*	.046	.100	.046	.100	*cb*
						.068	.260	*cb*
	.15	.790	.021*	.068	.260	.141	.219	*in*
						.736	.024	*in*
	.20	.790	.021*	.087	.495	.087	.495	*cb*
$(1,5)$	.10	.500	.055*	.077	.156	.077	.156	*cb*
	.15	.500	.055*	.102	.375	.168	.265	*in*
	.20	.500	.055*	.121	.645	.405	.088	*in*
$(2,5)$	.10	.562	.097*	.148	.175	.207	.148	*in*
	.15	.562	.097*	.193	.492	.426	.145	*in*
	.20	.562	.097*	.225	.901	.519	.110	*in*
$(5,5)$	.10	.664	.188	.336	.188	.500	.148*	*in*
	.15	.664	.188	.412	.682	.621	.175*	*in*
	.20	.664	.188	.456	1.22	.654	.186*	*in*
$(10,10)$	.10	.571	.296	.429	.296	.500	.189*	*in*
	.15	.570	.296	.472	1.07	.551	.256*	*in*
	.20	.570	.296*	.490	1.48	.566	.370	*in*

Note: $c_A = .1$; a star identifies the smallest MSE.

Table 2. Unobservable reporting costs

Beta	One-sender A		One-sender B		Two-sender		
(a, b)	y^*	MSE $(\times 100)$	y^*	MSE $(\times 100)$	y^*	MSE $(\times 100)$	Type
$(.5, 2)$	.694	.104*	.060	.217	.068	.219	*in*
$(1, 2)$	.720	.188*	.122	.272	.124	.234	*in*
$(2, 5)$	.440	.539	.180	.411	.222	.367*	*in*
$(5, 5)$	.605	.548	.395	.548	.500	.375*	*in*

Note: Costs are i.i.d and uniformly distributed over $\{.05, .1, .15, .2\}$.

Table 3. Symmetric Beta priors and identical costs

Beta		One-sender A		One-sender B		Two-sender		
(a,b)	c	y^*	MSE ($\times 100$)	y^*	MSE ($\times 100$)	y^*	MSE ($\times 100$)	Type
$(10,10)$	.10	.571	.29632	.429	.29632	.5	.18958*	*in*
	.05	.681	.02022*	.319	.02022*	.5	.02784	*in*
	.02	.832	.00003*	.168	.00003*	.5	.00186	*in*
$(20,20)$	.10	.523	.31835	.477	.31835	.5	.10880*	*in*
	.05	.589	.04873	.411	04873	.5	.03731*	*in*
	.02	.730	.00009*	.270	.00009*	.5	.00262	*in*
$(30,30)$	.10	.511	.27992	.489	.27992	.5	.21277*	*in*
	.05	.554	.06710	.446	.06710	.5	.04319*	*in*
	.02	.668	.00031*	.332	.00031*	.5	.00319	*in*

Note: c_A= c_B= c; a star identifies the smallest MSE.

References

[1] Aumann R. (1990) "Nash Equilibria Are Not Self-Enforcing," in J. J. Gabszewicz, J.-F. Richard, and L. A. Wolsey, eds., *Economic Decision-Making: Games, Econometrics and Optimization.* Amsterdam: Elsevier.

[2] Baliga S., Morris S. (2002) "Co-Ordination, Spillovers, and Cheap Talk," *Journal of Economic Theory*, 105, 450–468.

[3] Bhattacharya S., Mukherjee A. (2013) "Strategic Information Revelation when Experts Compete to Influence," *RAND Journal of Economics*, 44, 522-544.

[4] Bhattacharya S., Golstman M., Mukherjee A. (2014) "On the Optimality of Diverse Expert Panels in Persuasion Games," mimeo.

[5] Cheong I., Kim J.-Y. (2004) "Costly Information Disclosure in Oligopoly," *Journal of Industrial Economics*, 51, 121-132.

[6] Demougin D., Fluet C. (2008) "Rules of Proof, Courts, and Incentives," *RAND Journal of Economics*, 39, 20-40.

[7] Dewatripont M., Tirole J. (1999) "Advocates," *Journal of Political Economy*, 107, 1-39.

[8] Emons W., Fluet C. (2009) "Accuracy Versus Falsification Costs: The Optimal Amount of Testimony," *Journal of Law, Economics, and Organization*, 25, 134-156.

[9] Farrell J., Rabin M. (1996) "Cheap Talk," *Journal of Economic Perspectives*, 10, 103–118.

[10] Gentzkov M., Kamenica E. (2015) "Competition in Persuasion," mimeo.

[11] Gerardi D. R., Yariv L. (2008) "Costly Expertise," *American Economic Review Papers and Proceedings*, 98, 187-193.

[12] Gul F., Pesendorfer W. (2012) “The War of Information,” *Review of Economic Studies*, 2, 707-734.

[13] Hay B. L., Spier K. (1997) “Burden of Proof in Civil Litigation: An Economic Perspective,” *Journal of Legal Studies*, 26, 413-431.

[14] Jolowicz, J. A. (2000) *On Civil Procedure*. Cambridge: Cambridge University Press.

[15] Jovanovic B., (1982) “Truthful Disclosure of Information,” *Bell Journal of Economics*, 13, 36-44.

[16] Kartik N. (2009) “Strategic Communication with Lying Costs,” *Review of Economic Studies*, 76, 1359-1395.

[17] Kim C. (2014) “Adversarial and Inquisitorial Procedure in Information Acquisition,” *Journal of Law, Economics, and Organization*, 30, 767-803.

[18] Milgrom P. (1981) “Good News and Bad News: Representation Theorems and Applications,” *Bell Journal of Economics*, 12, 380-391.

[19] Milgrom P., Roberts J. (1986) “Relying on the Information of Interested Parties,” *RAND Journal of Economics*, 17, 18-32.

[20] Shin H. (1998) “Adversarial and Inquisitorial Procedures in Arbitration,” *RAND Journal of Economics*, 29, 378-405.

[21] Verrecchia R. (1983) “Discretionary Disclosure,” *Journal of Accounting and Economics*, 5, 179-194.